

**THE MYTHS OF MATERNITY: A COMPARATIVE STUDY OF THE
MEDICAL AND MYTHOLOGICAL PRACTICES OF HIGHLAND
TIBETAN POPULATIONS TO PROVE CULTURAL ADAPTATIONS
TO HIGH-ALTITUDE HYPOXIA**

A Senior Scholars Thesis

by

STEPHANIE LYNNE SHIVELY

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2008

Major: Anthropology

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Approved by:

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ABSTRACT

The Myths of Maternity: A Comparative Study of the Medical and Mythological Practices of Highland Tibetan Populations to Prove Cultural Adaptations to High-Altitude Hypoxia (April 2008)

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This paper presents the physiological adaptations to high altitude present in Tibetan and Nepalese populations, and reviews of the cultural practices surrounding childbirth which appear to have a connection to the stresses of hypoxic conditions. It concludes that the religious, secular, and folklore-related birthing rituals present in Tibetan and Nepalese society can be seen as cultural adaptations to high altitude stress. The paper also expands the work of past studies, combining physiological and cultural research in order to argue the existence of a cooperation between environmental and cultural stresses. It goes on to show that the cultural rituals surrounding childbirth in Tibet and Nepal act to enhance the environmental stresses in order to weed out the less well adapted infants, speed up the return of the mother to reproduction, and mollify the dangerous aspects of the environment for those that survive. By doing so, the cultural rituals work with the environment in order to increase the occurrence of adaptations to high altitude stress.

DEDICATION

To the people of Tibet,
fighting for their lives and their freedom.

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CHAPTER I

INTRODUCTION

A great deal of research exists analyzing the effect of high altitude stress on fertility and fecundity rates in both the Andes and the Himalayan mountain ranges (Zamudio and Moore 2000) (Moore 2003) (Moore 2004) (Adams et al 1995) (Zamudio et al 1993) (Thapa et al. 2000) (Wiley 1994). Studies have found high altitude hypoxia to correlate with low birth weights and subsequently increased infant mortality rates (Wiley 2002), as well as “chronic and progressive” IUGR (Zamudio 2000). Researchers have discovered the effects of lowered barometric pressure and decreased oxygen levels on biological processes as microscopic as the thickness of the pulmonary wall (Saldana and Aria-Stella 1963) and as broad as an individual’s inability to reach full aerobic capacity (Wu and Kayser 2006). The data is abundant and the results seem to point to the fact that 30,000 feet exceeds all individuals' biological reach.

Wu (2001) points out, however, that there are a handful of populations that succeed in subsisting at altitudes as high as 5800 meters, or a little over 19,000 feet. The Nepalese and Tibetan highlanders of the Himalayas do precisely that, exhibiting a unique adaptation, not seen in any other area of the world. Not only have they been found to exhibit a “major gene for oxygen saturation” (Beall 2000b) but they somehow avoid

This thesis follows the style and format of *American Anthropologist*.

the cripplingly common CMS (Chronic Mountain Sickness) altogether (Wu 2001). Additional studies into birthing patterns have also found that Tibetans very rarely develop IUGR during pregnancy (Zamudio 1993).

The information is far from lacking, however, until now, the influence of socio-cultural factors on Tibetan and Nepalese individuals' unique ability has been all but ignored. The few studies that have approached the issue from a cultural perspective have done so by looking at factors such as medicinal plants and herbs (Kunwar et al. 2006) or socio-economic status. This paper explores the evidence that although physical adaptation accounts for a great deal of the difference in birth rates between Tibetan and Nepalese highlanders and their low- altitude counterparts, the effect of cultural practices contributes heavily and cannot be discounted. It presents the cultural factors such as folklore, religious, and secular rituals which can be seen as cultural adaptations to high altitude stress. It presents their varied practices and shows how they effect and enhance the ability to subsist at extreme altitude in a significant way.

CHAPTER II

BACKGROUND

Effect of altitude stress on the body

Various populations handle similar environmental stress in different ways. Nowhere is this more evident than in the native residents of Tibet and Nepal. Nestled among some of the tallest mountains in the world, the Tibetan plateau reaches an elevation of over 5,000 meters and is nicknamed the “Roof of the World” (Wu 2004:1). In her 2004 article, Wu explains that while the recent influx of lowland Han immigrants following the latest mining and railroad construction surge has dramatically changed the population of both Tibet and Nepal, a majority of the residents have lived among the high altitude peaks for many generations longer than even the Quechua of the Andes. As a result, Tibetan and Nepalese highlanders have a number of unique physiological adaptations to high altitude that allow them to survive at elevations that are uninhabitable to the majority of life forms.

Most humans are not adequately adapted to live at extreme altitudes. Lowered barometric pressure coupled with decreased oxygen saturation in the air makes it difficult for all respiratory, non-adapted organisms to obtain enough oxygen to maintain regular cellular function. As shown in Table I, the result in most animals is hypoxia, a condition in which the bodily tissues are deprived of a sufficient amount of oxygen to rely on aerobic cellular respiration. Individuals suffering from hypoxia experience an

increase in anaerobic cellular respiration which produces an excess of lactic acid as a byproduct (Marieb 2007:303). The build up of this caustic substance causes symptoms such as headache, fatigue, or shortness of breath, and in extreme cases, seizure, coma, and even death.

When hypoxia is coupled with polycythemia, a condition characterized by an increase in red blood cell production meant to compensate for low blood-oxygen levels, also shown in Table I, the product is known as chronic mountain sickness (CMS). This condition raises hematocrit levels and, in extreme cases, can result in congestive heart failure, if left untreated (Léon-Velarde et al. 2005). Usually remedied by descent to sea level, (Wu and Miao 2002) it is just one of the many difficulties individuals living at high altitude may face. Increased sun exposure and lowered temperatures also help to drive humans closer to sea level, however, they do not seem to have as pronounced of an effect.

Although these conditions seem to be inevitable results of life at extreme altitude, as mentioned earlier, they do not affect all human beings. The ability of the native residents of the Himalayas to withstand the altitude related stresses of hypoxia exceeds not only that of the lowland Han, but that of other high altitude inhabitants as well. Wu reports (2001), that Tibetan and Nepalese individuals are virtually impervious to the effects of CMS, unlike their South American high altitude counterparts, the Quechua Indians of the Andes, who continually suffer from the painful condition. According to Wu (2004), this difference may be attributable to the wide use of medicinal plants found exclusively on

the Tibetan plateaus, known to treat the disease. On the other hand, it could be related to the rarity of periodic breathing and sleep apnea found in Tibetan highlanders, which prevents them from desaturating throughout the night (Wu and Kayser 2006). Although it is unclear whether either of these specific adaptations, if any, protects Tibetans from experiencing this otherwise universal effect of altitude, it is beneficial to this study to look at all of the different postulated adaptations

Table I. Medical conditions common at high altitude*

	Hypoxia	Polycythemia	CMS	HAPH
Condition	Deficiency of oxygen in the blood	Increase in red blood cell production in order to to compensate for low blood oxygen levels	Excessive erythrocytosis, severe hypoxemia (insufficient oxygen to bodily tissue), and possibly pulmonary Hypertensions	Mean pulmonary artery pressure >30 mmHg or systolic pulmonary artery pressure >50 mmHg, moderate hypoxemia, no polycythemia
Symptoms	Headache, fatigue, shortness of breath, changes in consciousness, seizure, coma, death	Headache, weakness, ringing ears, dizziness, high blood pressure, blood clots	Headache, dizziness, breathlessness, palpitations, sleep disturbance, fatigue, change in memory, congestive heart failure, death	Dyspnea, cough, cyanosis, sleep disturbance, irritability, right heart failure
Treatment	Descent to low altitude	Descent to low altitude	Descent to low altitude	Descent to low altitude

* The information in this table was taken from: (Leon-Velarde et al. 2005) and (Marieb and Hoehn 2007:656)

Another possible explanation for Himalayan highlanders uncommon ability is their unique blood oxygen concentration. While Tibetan and Nepalese highlanders do not exhibit higher hematocrit levels like most other high altitude residents, C. M. Beall (2000b) reports that a significant gene for oxygen saturation has been discovered within their population. In other words, although the typical response to prolonged hypoxia is an increase in red blood cell production, Tibetans maintain a fairly normal hematocrit level by having a higher concentration of oxygen in each individual blood cell. These normal levels not only help explain the absence of CMS, which is characterized by increased hematocrit, but indicate a specific sort of adaptation that affects the actual function of the erythrocytes, as opposed to simply stimulating their production. For such a radical alteration to be homogeneous across Tibetan populations indicates that the ancestors of native Himalayan inhabitants may have adapted to this environment over several hundred generations/thousands of years.

Another major adaptation which is likely to be related to high altitude stress concerns the cardiac muscle and the lifeblood it pumps throughout the body. Saldaña and Arias-stella showed that some high altitude natives exhibit an “elastic configuration of the pulmonary trunk,” and that data shows “that pulmonary hypertension is the determining cause” (1963:1094). As shown earlier in Figure I, HAPH (High Altitude Pulmonary Hypertension) is a common disorder in high altitude populations, which usually impedes normal function of the cardiac valve, forcing the myocardium to work harder in order to open it and pump blood through it and eventually resulting in thinner, weaker pulmonary

walls (Marieb 2007:704) (Leon-Velarde et al. 2005). Most individuals' hearts, when exposed to the increased resistance caused by chronic hypertension, develop enlarged myocardiums which eventually weaken and then slacken, leading to heart failure (Marieb 2007) Native highlanders, on the other hand, retain their pulmonary trunk elasticity from childhood, enabling their hearts to deal with the increased stress.

Effect of altitude stress on pregnancy

The pressures of high altitude are driving forces of change in all aspects of life for those living in that environment. They have the most pronounced affect, however, on those who are forced to perform vigorous endurance activities. Pregnancy is a physically taxing, and energy expensive process which puts increased stress on the human body at low altitudes, let alone high. In addition to that, the actual birthing process only acts to increase the strain on an already exhausted heart and body. By definition, reproduction is an endurance activity and recent tests by Wu and Kayser (2006) have shown that hypoxia typically has a much more pronounced effect on long term endurance activities than on short term aerobic exertions. Around the globe mother and infant mortality rates are high in developing nations, and the added strain that high altitude exacts only acts to increase that number. The hypoxic conditions weaken the mother by providing an insufficient supply of oxygen, leading to a depleted immune system and diseases that are detrimental to both her health and her fetus'. At the same time, the stresses of high altitude diminish the unborn child's ability to survive in the womb. It is an attack on two fronts, where not only the mother, but the child is at risk.

As mentioned previously, most high altitude populations maintain elevated hemoglobin levels to counter the low concentration of oxygen in the air. While this may help to facilitate cellular respiration, recent research has found a negative side effect. In a study conducted in 2000, Scanlon et al determined that there is a correlation between high hemoglobin levels and both small-for-gestational-age births, and pre-term deliveries. It can, therefore, be inferred that high altitude populations with high increased hemoglobin levels have a higher percentage of preterm births, as is shown in Table II. Premature births carry their own set of risks which may contribute to the high infant mortality rates at any altitude, but the low birth weight also characteristic of high hemoglobin levels puts an infant at increased risk of dying before childhood.

Wiley (1994) demonstrated that low birth weights, classified by the World Health Organization (WHO) as all newborn infants weighing less than 2,500 grams or 5.5 lbs, are associated with high infant mortality rates during the first year of life at extreme elevation, as shown in Table II. Low birth weight in general is related to a reduced likelihood of surviving those fragile months, as it is often associated with intrauterine growth retardation (IUGR) as a result of stress during the early neonate period (Wiley 1994). Unlike lowland fetuses, however, highland infants have more factors determining their birth weight than simple maternal nutrition; as mentioned earlier, they must also combat the side effects of maternal adaptations such as increased hemoglobin levels. Ironically, the same adaptation which helps the mother to survive may inadvertently cause her child's death. Such is the way of evolutionary adaptation: it is neither

directional nor without flaw, and as a result, may cause its own disappearance.

Table II. "Maternal and infant characteristics in the low altitude (Kathmandu) and high altitude (Lhasa) samples" (Zamudio et al 1993)

	Low altitude (45 samples)	High altitude (34 samples)	<i>P</i>
Maternal			
characteristics:			
Maternal age (yrs)	28 ± 1	25 ± 0.5	<.05
Gravidity (no. of pregnancies)	2.8 ± 0.3	1.5 ± 0.1	<.05
Parity (no. of live births)	1.8 ± 0.3	0.4 ± 0.1	<.05
Primiparous (%)	31	58	<.05
Weight at wk 36 (kg)	60 ± 1	58 ± 1	NS
No. of pre-natal visits	6.2 ± 0.5	5.4 ± 0.7	NS
Height (cm)		158 ± 1	
Body fat (%)		26 ± 1	
Infant			
characteristics:			
APGAR score at 1 minute	8.0 ± 0.2	7.5 ± 0.2	NS
Birth weight (g)	3313 ± 79	3222 ± 90	NS
Gestational age (wk)	39.3 ± 0.3	39.7 ± 0.3	NS
Pre-term (< 37 wk) (%)	7	3	NS
Post-term (> 42 wk) (%)	4	0	NS
Low birth weight (< 2,500 g) (%)	0	3	NS
Female (%)	60	53	NS
Male (%)	40	47	NS

Altitude is not always so direct in its effects, however, and has other, more round about

ways of influencing infant mortality rates. Preeclampsia is a fairly common disease affecting ten percent of all pregnancies. It is characterized by elevated maternal blood pressure, insufficient blood and oxygen supply to the fetus, and proteinuria (the presence of protein in the urine) and puts both mother and child at increased risk of death (Marieb and Hoehn 2007). Treatment is usually limited to immediate delivery and therefore, many mothers afflicted with the condition end up giving birth prematurely. As discussed earlier, premature birth can result in both low weight and underdeveloped infants, and both of these conditions are correlated with increased mortality rates.

In a Colorado based study, Palmer et al. (1999) determined that the frequency of preeclampsia is greater at high elevations due to the way high altitude hypoxia restricts the typical vascular compensations seen in pregnancies at regular altitudes. Most pregnant women experience decreased blood pressure, which is thought to be the result of “primary peripheral vasodilatation,” so extreme that the body cannot compensate for it with the “increase in plasma volume and cardiac output” common during pregnancy (Palmer 1999: 1165). This blood pressure drop is uncharacteristic of high altitude pregnancies, however, which indicates that the decreased oxygen and barometric pressure somehow interfere with the body’s vascular response to pregnancy. This complication predisposes the mother to developing preeclampsia.

The Palmer et al (1999) study also showed that hypoxia related preeclampsia may be associated with an increase in the occurrence of Intrauterine Growth

Retardation/Restriction (IUGR). The condition has been found to correlate with a lowered maternal blood volume, which is a condition found in high altitude dwelling individuals. Despite Colorado's lower elevation, the results of this study are significant, especially with regards to their ramifications on individuals from areas such as the Himalayas which have even higher altitudes. IUGR causes fetuses to develop more slowly in utero and often results in low birth weights as well as other various problems. While such developmental inhibitions usually only affect the neonate during specific phases of growth, in high altitude cases S. Zamudio and L.G. Moore (2000:6) found the process to be “both chronic and progressive,” causing more dramatic growth retardation and, therefore, a more pronounced threat to the fetus.

Effect of altitude stress on pregnant women in Tibet

The unique high altitude adaptations of the Himalayans extend to reach all necessary areas of life. Wherever there is a physically taxing demand there seems to be an equally impressive modification. Sherpas, for instance, who frequently hike to the unfathomable height of the peak of Mt. Everest, do so without oxygen tanks or the dangerous and painful symptoms of acute mountain sickness. Wu and Kayser showed they rely primarily upon a three-part adaptation. Not only do they exhibit an increased breathing rate and a higher affinity of blood for oxygen, but they have the ability to “reach a higher fraction of [their] low-altitude aerobic capacity” under hypoxic conditions (2006:195). These physiological adaptations allow the Sherpas of Nepal to exert themselves without being hindered by the depleted oxygen content in the air.

While it may not seem as extreme as hiking up the peaks of the Himalayas, pregnancy and reproduction are also fairly demanding physical tasks, and not surprisingly, are also accompanied by a list of unique adaptations. Beall (2000a) showed that oxygen concentration increases in all Tibetans throughout the first decade of life. It then maintains this high level in men until they enter their 20s and in women well into their 40s or 50s (Beall 2000a). Such a drastic sexual difference in the decline of oxygen saturation indicates its importance in the reproductive process. It may be more beneficial for women of childbearing years to have an increased supply of oxygen in order to better prepare for the onset of pregnancy. At the same time, however, Beall (2000a) showed Tibetan women are reported to experience early onset of menopause, at an average age of 46.8, in addition to delayed initiation of menarche, at an average age of 16.2. While the late start to the menstrual cycle may be related to the prevalence of delayed growth development among fetuses, the cause of the early menopause is as of yet, unknown. It is possible that Tibetan women's bodies simply may not be capable of sustaining such a high level of oxygen saturation any longer. Even well adapted physiques grow weary after nearly 50 years.

The unusual adaptations of Himalayan residents to their high altitude surroundings are responsible for notable differences from the fertility and fecundity rates of the surrounding Han populations. Having only recently arrived on the Tibetan plateau in the last fifty years, these lowland residents followed new railroad and mining jobs to one of

the highest places on earth (Zamudio and Moore 2000). The results are manifesting themselves in the form of high frequency of CMS (chronic mountain sickness), SIMS (subacute infantile mountain sickness), and low fertility rates.

In order to solve these problems, Wu and Miao (2002) explain that many pregnant Han women are forced to descend to sea level to give birth and raise their children, up until their first year. This is a practice absent in Tibetan culture. It is not, however, absent in all high altitude populations, as a similar practice is reported in certain Andean groups of Spanish heritage who are not well enough adapted to survive the stressful conditions on their own (Moore et al 1998). As a general rule though, highland populations across the globe are found to experience less “intrauterine growth retardation, better neonatal oxygenation, and more complete neonatal cardiopulmonary transition” than their lowland counterparts at altitude, thus better equipping the fetus for the birthing process (Moore et al. 1998:25). The mother’s increased oxygen saturation lessens the stress on her body, causing maternal death rates to be suppressed as well.

Tibetans in general have significantly higher birth rates, weights, and survival statistics than their Han counterparts, indicating that there is some genetic difference between the populations (Moore et al. 1998). The Han, as well as most other poorly adapted high altitude dwelling individuals do not share that genetic modification and must instead work their way around it with cultural practices such as descent to lower altitude. They are not, however the only ones using cultural practices to their advantage, as will be

shown later in this study.

While most high altitude residents suffer from the effects of IUGR during pregnancy, as shown previously in Table II, Tibetan women are far less susceptible, indicating they have developed a resistance to the selective pressures of high altitude stress (Zamudio 1993). Himalayan children not only avoid the detrimental effects of a developmental malfunction, but they also seem to be affected very little across the board by their mothers' surroundings. In fact, Zamudio et al. (1993) determined that Tibetan neonates born at altitude tend to be approximately the same size as low altitude infants born at sea level. It is as if the high altitude stress is virtually non-existent to the fetus. This increase in size subsequently heightens the child's chances of survival, thus broadening the gap between lowland and highland populations' morbidity and mortality rates at altitude.

Effect of cultural practices on altitude stress

There are always multiple perspectives to every story, so it is not surprising that a focus on physical adaptations does not cover every possible cause of the differences between low altitude and high altitude populations' fertility and fecundity rates at extreme elevations. Although Tibetan and Nepalese populations have lowered fertility rates, their mortality rates, as previously discussed, are higher than their lowland-adapted neighbors. While death rates appear to be strongly influenced by physical adaptation, as Goldstein et al (1983) argued, fertility and fecundity rates (particularly among Sherpas) are more

influenced by social pressures than environmental ones. Especially since hypoxia does not appear to have as pronounced an effect on high altitude natives such as the Tibetans and Nepalese of the Himalayas as it does on lowlanders (due to natives' adaptations), in order to understand the factors still affecting their fertility and mortality rates one must look at other elements such as cultural practices and socioeconomic factors.

The conditions at such high elevations are so harsh that it can be quite difficult to scrape out a living. The steep slopes are far from ideal for widespread agriculture and few plants and animals, let alone people, can survive the often deadly combination of depleted oxygen concentration and low barometric pressure. Aerobic cellular respiration is restricted and many complex organisms' tissues cannot handle the oxygen loss. As a result, most of the groups that originally settled such harsh and remote areas did so out of necessity. Pushed out of the more fertile lowlands for various reasons, many populations such as those situated in the Himalayas exhibit poor socioeconomic standing which can lead to issues of health and wellbeing (Wiley 2002).

A lack of money often precipitates a lack of food, which can be devastating to a growing young child. Without enough calories, either from breast milk or solid food, an infant or toddler will suffer serious health problems and possibly death. It is therefore possible, that there is a direct connection between low socioeconomic status and high infant mortality rate (IMR). It is likely due to the increased IMR that most Tibetans wait until a child completes its first month of life before officially being named by a parent or the

high lama (Shen and Liu 1953). The initial period of high risk of death must be overcome, and the Tibetans and Nepalese use this cultural response to high IMR in order to meet that requirement.

Sadly, even when circumstances are perfect, cultural rituals can still inhibit a child's health and wellbeing, especially when they concern food. Dang et al. (2005) concluded that although an increase in altitude often lengthened the amount of time spent breast feeding, the inappropriately early introduction of supplementary dietary items such as *tsamba* (a barley and butter tea mixture) may contribute to high levels of malnutrition among Tibetan infants and youth. While *tsamba* has its benefits when used in conjunction with breast milk, as will be shown in the next chapter, on its own it cannot come close to replacing the plethora of vitamins, calories, and antibodies which are found in a mother's vital milk. Without the adequate nutrients required for growth, not even the high levels of fat provided by the buttery tea can make up for the deficits facing the child's body.

Food and money are not the only cultural factors relevant when studying fertility and fecundity rates and comparing them across cultures. Also important is consideration of the age-at-first-birth data point. Fricke and Teachman (1993) for instance found in their study concerning the Tamang of Nepal that those individuals taking part in the historic practice of cross-cousin marriage and who dwell in the presence of natal kin exhibit a faster entrance into the childbearing stage. Such women have their first child earlier in

life than those involved in the more recent marriage rituals. Fricke and Teachman (1993) suggest that this may be the result of a feeling of comfort and belonging, or a response to a lighter workload than women who go to live with a husband's family. This study argues that the practice also affects the child after birth, in that he or she may also be more accepted if the result of a cross-cousin marriage situation, as an endogamous coupling would produce offspring that is connected to the family through both parents instead of just one. Such a position would be important in a situation in which children often find themselves struggling for survival. Therefore, it can be argued that cross-cousin marriage should be seen as a type of cultural insulation from the causes of high IMR and as a cultural spur to fertility rates.

CHAPTER III

RITUALS: RELIGIOUS AND SECULAR

Life at high altitude is difficult for the highlanders of Tibet and Nepal. They face a number of political and socio-economic issues in addition to the aforementioned physiological stresses of residing at extreme altitudes. Either of these issues would raise mortality rates by themselves, but coupled with the pressure of an inhospitable environment, they can prove fatal to many. In order to survive and prosper, the Tibetan and Nepalese cultures must develop a way to confront both issues. Addressing the environmental factors alone, while beneficial, would only help half of the problem. The increased death rate must be compensated for, and this chapter will discuss the role folklore and ritual play as cultural adaptations to high altitude stress, and their effectiveness in dealing with the mortality rate.

Before this section continues, it is important to emphasize that Tibetan and Nepalese individuals *are* aware of the fact that they subsist in a hostile environment. It can be easy to get carried away by religious and folklore studies and jump to the conclusion that all adaptive rituals are masked by intricate and seemingly unrelated explanations. That, however, is not true, and is a dangerous assumption to make, as it can lead to both over and under-interpretation.

With that in mind, it is important to this study to point out that culture is malleable, and

capable of being molded into useful methods of dealing with various forms of stress. In Tibet and Nepal in particular, many of the rituals, both religious and secular, as well as folklore-related, contain elements which can be seen as adaptive to both the stresses of the environment, as well as the increased mortality rate. Most of the rituals discussed in this chapter deal with these stresses in one or more of the following ways

1. It deals directly with the stresses of the harsh high altitude environment.
2. It helps to weed out those individuals less capable of surviving the stressful conditions.
3. It help the society to cope with the high infant mortality rate, thereby decreasing the mourning period and increasing the mother's probability of becoming pregnant again soon after.

By performing these three functions, the rituals can be seen as adaptive responses to the adverse conditions which the people face as a whole. These functions are not seen in only one type of ritual, but are instead spread across the religious, folklore, and secular traditions of the society. In this way, they address all aspects of the childbirth process, from pregnancy through infancy, and increase the speed of the natural process of adaptation, as well as the ability of the Tibetan and Nepalese highlanders to survive in an area uninhabitable to most.

Buddhism

As the origin of Tibetan Buddhism and the former homeland and place of residence of

the now exiled Dalai Lama, Tibet, as well as neighboring Nepal, is an important hub of the Buddhist faith. It is, therefore, not surprising that the highlanders of Tibet and Nepal engage in a number of religious rituals associated with Buddhism throughout their lives. While the number and variety of these practices are large, this study will focus on those surrounding the periods of pregnancy, birth, and infancy.

The first ritual that will be examined is the baptism, a ceremony which usually takes place three days after birth and is conducted by a lama from a nearby monastery (Combe 1994). It is an important religious ceremony, lasting half a day to a whole day, and incorporates prayer and the use of talismans, as well as the ritual eating of tea, sugar, and a substance made of barley and butter known as *tsamba* (Combe 1994). While seeming to have nothing to do with altitude stress, this ritual serves two important functions in adaptation.

The first and most direct deals with the environmental stresses of high altitude through a method that appears in many other religious and folklore-based rituals. It is the consumption of butter, and according to the USDA, it is a very common practice in South Asian countries (Coffing 1999). The significance of this practice seems to lie in the high caloric content of the foodstuff. Butter is a significant source of fat, and as such, provides vital calories in a society where food is difficult to come by. This is not only important for the lactating mother (breast feeding is a calorie-expensive practice), but it is also important to the developing child. According to the Maternal Child Health

Bureau, healthy, full-term infants require approximately “118 kcal/kg/d at one month of age to about 92 kcal/kg/d at 6 months of age” (Maternal Child Health Bureau 2007).

Butter not only helps to fulfill that caloric requirement when consumed with appropriate amounts of breast milk, but it also facilitates the development an important layer of insulating fat which can help protect against the low temperatures so common at extreme altitudes.

Another beneficial aspect of the consumption of *tsamba* is that it also contains barley, which is an adequate source of the nutrient folate and an excellent source of thiamin. Both vitamins are important to cellular and nervous system function, and are especially beneficial for pregnant and nursing women in order to prevent neural tube defects such as Spina bifida, as well as other damaging developmental issues in their offspring (Hernandez-Diaz et al. 2001). By consuming *tsamba* early and often, both mother and child are increasing their nutritional levels in a region where resources are scarce and food can be hard to come by.

The second important function of this baptism ritual is the way in which it helps to deal with the increased mortality rate. This aspect is closely related to the religious beliefs of Tibetan-Buddhism. The Buddhist teaching of reincarnation has a significant impact upon the thoughts and actions of both the community and individuals towards the childbirth process. It stresses the concept of rebirth, in which a person’s soul or essence is reborn into a new body, following death (Lauf 1977). For that reason, a child is thought of more

as a new form of an old spirit, than as a completely new and unique soul. In fact, it is believed that infants retain the memories of their past life at birth and lose them incrementally over time, with each developmental milestone (Combe 1994). This particular view of reincarnation reinforces the concept of the body as merely a receptacle for the soul. The spirit has no attachment to it at first and, therefore, the loss of the physical shell early in life is not seen as a significant sacrifice, as it would be at a later age. In short, the baptism ritual acts to remind all individuals involved that death is not a permanent loss, and that the forfeit of one body will ultimately result in the acquirement of a new one. This helps to soften the blow in the case of a child's death, thereby helping a family to move on more quickly, and speed up their return to the process of procreation.

The second religious ritual to be examined, the naming ceremony, also deals with the role of the Buddhist teaching of reincarnation in instilling a distance between parents and their children. This important rite incorporates three separate methods of dealing with the stresses of life among the Himalayan peaks. While some individuals choose to combine the naming ceremony with the previously mentioned baptism ritual three days after birth, many of the poorer residents choose to wait until the child is older. The length of the postponement can range anywhere from the typical one month, to a full year, and some families even postpone the ritual indefinitely, leaving the child instead with a permanent pet name such as *Patru* or *Chitru* (“piggy” or “doggy”) (Shen and Liu 1953) (Combe 1994:60). This interval of waiting is particularly relevant to this study because

it is an indicator of the high infant mortality rate. Parents wait to have their child named until they are sure that the infant is likely to survive.

A similar practice was documented by Scheper-Hughes (1993) in the Northeastern Brazilian town of Alto do Cruzeiro, where mothers often leave their infants unnamed until they are more than a year old, to prevent becoming too attached. This can be seen as a form of self-preservation for the mother, in a society where infants' odds of survival are bleak at best. "In their slowness to anthropomorphize and personalize their infants," Scheper-Hughes explains, all of a mother's actions are "mobilized so as to prevent maternal over attachment and, therefore, grief at death" (1993:35). The depression associated with any type of mourning, particularly prolonged grief, tends to have an adverse effect on reproduction. When coupled with a high infant mortality rate, such a condition could lead to a decrease in reproduction and subsequently to a decreasing population. If severe enough, that could eventually have a significant impact on the size of the population. Therefore, a set of "lifeboat ethics," as Scheper-Hughes labels them, is necessary to facilitate the continuation of the society (1993:35).

The timing of the ceremony is not the only aspect of the naming ritual which helps to create an emotional buffer between children and their parents in Tibetan and Nepalese society. During the rite, an infant usually receives his or her name from the presiding lama, and on top of that, does not inherit a family name from his or her parents (Combe 1994). This tradition comes from the Buddhist belief that the child is not an extension of

the parents, but rather a new physical form of a preexisting soul. In fact, the child is thought to bear “no relation to its parents,” except through the physical body which they created; “father supplying the bones and the mother the flesh” (Combe 1994:58-9). By giving the child a completely separate name from the parents, it emphasizes this point, and attempts to prevent further attachment. The ritual also places emotional distance between parent and child, as well as reinforces to all those involved the temporal nature of both the body and the physical world.

Folklore

While the impact of the Buddhist belief in reincarnation cannot be minimized, it is also important to look at other folklore-related rituals that help to protect against the harsh environment of the Himalayan highlands. It is often the case that beneficial practices which help to increase survival rates or standards of living can be adopted into the social traditions or institutions of a culture over time. These norms are then upheld through the use of folklore which is, in the words of Alan Dundes, “employed to control, influence, or direct the activities of others from the time the first lullaby is sung” (Dundes 65) The original purpose may be lost, but the practice remains, building a framework of superstitions and beliefs around itself. Therefore, it is likely that by studying the superstitions and ritual behaviors surrounding childbirth in Tibet and Nepal, the original adaptive purposes may filter to the surface.

As is true of most societies, there are a number of superstitions that surround the periods

of conception, pregnancy, and childbirth in Nepal and Tibet. For research purposes, however, this study will focus primarily on those superstitions which govern behavior before or during childbirth, and that dictate what actions should be taken after the child has been born. The first to be addressed is a belief that it is bad luck for an expectant mother to reveal the date that her baby is due. The custom continues to stipulate that for every violation of this taboo, the birthing process will be delayed by one hour, and therefore become more painful and difficult for the mother (Combe 1994). In a 2005 study, Adams et al. discovered that many Tibetan women associated the occurrence of a miscarriage with other people knowing the woman's due date.

The result of this superstition is that except among the wealthy, doctors and midwives are virtually unknown to the birthing process, perpetuating its image as “a completely natural function” (Tucci 1967:154). Instead of being associated with danger, weakness, and/or possible death, childbirth is seen as a process which requires incredible strength. A woman must be virile enough to give birth on her own and care for her baby in order for both mother and child to survive. In addition to these stipulations, she is forbidden to take time to recover, as sleep during the day is thought to induce fever. Instead, she must draw upon her strength and return to her normal tasks almost immediately (Bell 1992). The weak and sickly (in addition to those who have complications during birth) are unable to survive this practice, and therefore to procreate. This article argues that the result is a form of ritual weeding out. Those individuals with any type of condition or complication which would hinder a smooth delivery are weeded out, and unable to pass

on their genetic information.

Closely associated with the superstition concerning a woman's birth date is another custom which helps to ensure that only the strong survive. Adams et al (2005) noted that births are also usually carried out in barn or animal shed or “in a part of the house that is not inhabited by a spirit deity,” in order to protect the vulnerable infant (Adams et al 2005: 828). These structures are usually located under the familial dwelling, which gives them the added benefit of keeping with the belief that it is good luck for a woman to give birth on the ground floor. The tradition states that the closeness of the ground will make her delivery easier, and the proximity of the livestock will help her to have a smoother, more animal-like birth (Combe 1994) Unfortunately, as Thapa et al. (2002) pointed out in a recent study, this practice is shown to dramatically increase mortality rates in both the mother and infant due to unhygienic surroundings. The likelihood of contamination by infectious agents skyrockets due to the mere presence of both animals and feces. After birth, the practice of laying the newborn on a thin cloth on the ground and cutting the umbilical chord with the same, non-sanitized blade used for chopping daily firewood, only act to increase the risk of death (Thapa et al. 2002).

This ritual practice undoubtedly leads to an increased chance of infection and disease for both mother and infant, enhancing the likelihood that only those with the strongest immune systems survive. This study suggests that it can be seen as another instance of an unintentional, human-imposed bottleneck. Again, the stresses of the environment are

artificially augmented, to ensure that only those strong enough to withstand the actual threats continue on to reproduce. The weak and sickly are filtered out and so are all of their genetic predispositions. It is at this point that the folklore rituals blend with the religious beliefs of Tibetan Buddhism, and the loss to both the family and the society is cushioned by the knowledge that the departed souls will find their way back in a stronger, better suited body.

After the birth of the child, the superstitions and rituals do not cease, and it can be argued that their function as societal adaptations to environmental stresses and a heightened mortality rate do not either. Soon after a mother delivers her child, she is given a thick butter concoction in order to combat “wind” while the baby undergoes its ritual welcome to the world (Shen and Liu 1953:148). As previously discussed, the frequent consumption of butter by both mother and child may help to deal with the stresses of the physical environment in a straight forward way. Through it, the mother can gain calories needed for breastfeeding which she can then pass on to her child. That infant would subsequently consume a large number of fat calories which would help it to develop an insulating adipose layer. This lining of fat would then protect the child from the cold temperatures frequent in the mountains.

The after-birth ritual can be seen as having other benefits too, however. While the mother is busy eating butter, the child is being ritually crowned with it. According to tradition, soon after birth, a small amount of butter is placed on “the vein on the crown”

of the child's head to stop the aforementioned "wind" which the doctors believe causes "one-third of all human ailments"(Shen and Liu 1953:148). It is unclear what exactly the "wind" is that is being referred to, however, a literal translation may reveal an interesting possibility. The grease in butter is not only a good source of fat calories, but it is also a fairly reliable sealant capable of trapping moisture. Oil and water do not mix, so coating the skin with butter should keep the liquid away from the surface. In addition, it may also function as a thick layer of defense, protecting the infants' delicate skin from the sometimes harsh and biting mountain winds. Butter may be used like a natural moisturizer and protectorate, to prevent the skin from cracking and bleeding, and thereby stave off the potential for a serious and life-threatening infection.

Secular Cultural Traditions*

The comment in the previous section made by local Tibetan doctors that "the wind" is the cause of "one-third of all human ailments," raises an important point mentioned earlier in this study (Shen and Liu 1953:148). Not all rituals are cloaked in the disguise of religion or folklore. Some of the rituals surrounding the birthing process deal directly with the issue of environmental stress and do not fit into either the category folklore or religion. These will be referred to for the purposes of this study as secular rituals and practices. However, even rituals that purposefully try to deal with the tribulations of a harsh environment are multifaceted, and often address the problem in more ways than

*In this article, the term "secular" is meant to identify those rituals which do not fit into the classification of religious or folklore related, but instead deal more directly with the environment.

originally intended. It is in this light that even secular rituals that deal directly with environmental issues can also be seen as indirect cultural adaptations to the stresses of high altitude.

The first birthing ritual that will be discussed in this section appears fairly straight forward upon first glance. An old practice, considered by Shen and Liu to be “along Spartan lines,” has survived into the present and includes stripping infants, rubbing them all over with butter, and then setting them outdoors for hours at a time, in even the coldest months (1953:148). This study argues that this kind of exposure ritual can be viewed as a form of cooperation between cultural and physical factors, forcing adaptation to the pressures of high altitude stress. The ritual is meant to increase the infants' resistance to the harsh weather conditions, and is repeated a few times every month until they are three years old (Shen and Liu 1953:148).

Although the stated purpose of this practice is to build up weather resistance, this article argues that it has a more discreet and deadly effect as well. While healthy children may be strengthened by the repeated exposures, weak or sickly children have little to no chance. The sun exposure, extreme temperatures, and sometimes violent winds would prove dangerous enough for healthy infants, but when combined with decreased oxygen saturation and barometric pressure, they can be deadly to a weakened body, particularly one lacking any of the previously discussed physical adaptations. Only the strongest newborns would survive the ordeal, thus weeding out “weak” genes to protect future

generations. Those children who are less well suited for high altitude environment have a low probability of surviving the repeated exposures, and the already high infant mortality rate may disguise any deaths that this practice might produce by clumping them in with those who die of malnourishment or disease. Coupled with the encouraged detachment of parents from their children, and the coping benefits of the belief in reincarnation, such an obvious weeding-out ritual of the weak and ill-adapted (which would likely be condemned if its underlying purpose was to come to the surface) can slide by unnoticed, thereby ensuring its continuation.

This concept of ritual weeding out is not unheard of, or unique to the Tibetan and Nepales of the Andes. The aforementioned Greek society of Sparta for instance, has become rather famous in recent years for a less ambiguous form of the same practice. In that society the purpose of reproduction was to breed a strong and fearless warrior “race.” Children who were born disfigured or sickly were systematically thrown from cliffs to prohibit them from reproducing in the future (Schwarz and Isser 2000). In addition, the separation of mother and child was also enacted early on, with the sons in particular being removed from their mother's care at a very young age. Spartans were also raised to despise weakness, to insure that a mother would be less hesitant to part with an unviable infant. All of this led to a culture in which the strong survived and the weak were quickly discarded and forgotten. The final aspect of this culturally selective triumvirate was the fact that healthy, robust children were immediately inducted into a strenuous course of training meant to strengthen them and better prepare them to survive

the rigors they were sure to face (Rawson 1969)

Not all of the practices which can be viewed as ways to filter out the ill-adapted from the gene pool are as severe as the exposure ritual. In the Tibetan and Nepalese societies, those smaller, weaker sons who survive the trials of their youth for instance, are often shuttled off to the lamaseries for a religious life (Combe 1994). While the stated reason may be that they are not as well suited for the strenuous physical activity of peasant life, this paper argues that the unstated result is that those individuals are removed from the reproductive population. Llamas do not marry, and therefore they do not pass their genetic traits and weaknesses on to the future generations. Combined with the previously discussed exposure ritual, these two practices can be viewed in a different light and be seen as forms of culturally manipulated survival of the fittest.

This study argues, that by analyzing the information presented above, it becomes clear that factors other than just the physical environment can influence the process of adaptation. While cultural rituals cannot physically decrease the barometric pressure in the air, or lower the oxygen concentration, it can increase the exposure of individuals to those stresses in order to intensify natural selection. Similarly, while culture cannot cause biological mutations which may eventually develop into adaptations after many generations; it can speed up the rate of reproduction, and therefore the cycling of generations. This study presents religious, folklore related and secular rituals as cultural adaptations to high altitude stress, not because they biologically cause adaptations, but

because they augment the natural forces. They intensify and speed up the influence that the stressful, high altitude environment has on the populations of Tibet and Nepal, and in so doing, they account for the unusually high number of physical adaptations present.

CHAPTER IV

DISCUSSION AND CONCLUSION

Discussion

It is clear from the previous research that the native individuals of Nepal and Tibet exhibit unique biological adaptations to high altitude stress. They display increased breathing rates, higher affinity of blood for oxygen, more elastic pulmonary walls, and a relative absence of Chronic Mountain Sickness (CMS). All of this enables their bodies to maximize the insufficient oxygen content in the air, thereby allowing their people to survive the stresses of high altitude. As a result, the Tibetan and Nepalese peoples have been able to sustain life in a remote landscape, uninhabitable to most. It appears to be a very significant biological achievement, but at the same time it raises questions about how it happened and how long that many adaptations would actually take to develop naturally.

The nature of biological adaptation is that it is not directional. It is tempting to jump to the conclusion, when looking at a set of traits that appear to be adaptive, that they developed because the organism needed them to. The truth of the matter is, however, that adaptations start out as hundreds of thousands of random mutations, most of which disappear as quietly as they were created. In order for one of those mutations to develop into a beneficial adaptation, it must survive with its host and be passed down to future generations, usually due to its positive influence on its host organism's reproductive

success. It is a slow process, governed heavily by chance, and it usually takes many generations to develop naturally (Moore and Regensteiner 1983).

In this study, the significance of that fact about adaptation is that while some evidence of early habitation of the Himalayas has been found, it is unclear whether the Tibetan and Nepalese societies have existed in that particular environment long enough to account for so many unique abilities in their cache of adaptations. That incongruity, when viewed in conjunction with the fact that these populations also possess a number of adaptations specific to the birthing process, brings up the following important point. The women of Tibet and Nepal exhibit significantly higher birth rates, weights, and survival statistics than their lowland counterparts at altitude, as well as a much lower occurrence of Intrauterine Growth Retardation. Any one of these unique adaptations alone would be significant, but together they indicate the presence of strong selective forces at work. Not only that, but the fact that high altitude adaptations *should* translate into decreased infant mortality rates among native highlanders, but instead seem to have little to no impact on the surprisingly high IMR, also indicates that there is some element that is not being accounted for. This study argues that it all adds up to indicate that there is another factor influencing the natural processes of selection and adaptation.

The folklore and ritual research presented in this study reveals the existence of a set of rituals, which indirectly increase the speed of genetic turnover while simultaneously siphoning off individuals who are ill adapted to the harsh environment. While

functioning under a multitude of religious, secular, and folklore-related explanations, individually, they do not appear to have a pronounced effect. In conjunction, however, these rituals act in three important ways.

First they weed out those individuals less capable of surviving the grueling conditions of the Himalaya peaks through unsanitary birthing conditions, exposure rituals, and relegation of the weak to lamaseries. Secondly, they help parents to cope with the high infant mortality rate through rituals stressing reincarnation and rites that impose a distance between the parents and the child. These beliefs thereby decrease the mourning period and increase the mother's probability of becoming pregnant soon after the loss of a child. Finally, the rituals deal directly with the stresses of the harsh environment, strengthening those infants who survive the initial weeding out process through the consumption of high calorie foods and the application of protective treatments to safeguard them from the harsh elements. This therefore increases the likelihood of the strongest and best adapted to thrive and reproduce.

This study suggests that these cultural behaviors do in fact seem to serve a biological function in society, related to reproduction. It argues that they both augment and speed up the natural processes of environmental selection, thereby stimulating the possibility for an increased number of resulting adaptations. This would not only help to explain the possible origin of such rituals, but also account for the existence of so many extreme physiological adaptations to high altitude stress that are unique to the Tibetan and

Nepalese cultures.

Conclusion

Biologically speaking, it usually takes thousands of years and a great deal of chance for a random mutation to make the transition to adaptation. It is for this reason that many scholars have been baffled by the presence of such developed high altitude adaptations among the Tibetan and Nepalese highlanders, especially considering the relative absence of similar adaptations in other high altitude natives such as the Quechua of the Andes (Beall 2000b). As discussed previously, most account for the difference by sighting the assumption that humans have inhabited the slopes of the Himalayas longer than they have existed in the Andes. This study suggests, however, that the cause of the difference lies elsewhere: specifically in the religious, secular and folklore related rituals surrounding childbirth.

These rituals are structured in such a way that they have both manipulated and accelerated the forces which produce adaptations. They culturally exaggerate the concept of 'survival of the fittest' by purposefully exposing both child and mother to unnatural and extreme environmental stresses. Simultaneously, other rituals create and/or widen the chasm between mother and child, allowing those whose children do not survive the selection process to return to procreation more quickly. This result is especially important, considering Tibetan and Nepalese women's tendency towards delayed menarche and early onset menopause. Finally, other rituals help to protect and

bolster those children who do survive, so as to better prepare them for the real stresses of the environment in which they are to live and therefore increase their probability of passing on their genetic material.

Folklore in general cannot be pigeon-holed into any one classification or defined as having only one motivation. It is multifaceted, and develops over thousands of years for countless reasons. It is impossible to look at all of the different aspects of folklore as a simple whole and make broad, sweeping generalizations about the entire field. If analyzed in subsections, however, such as rituals, and then broadening the scope to include religious and secular rituals, it can be dealt with more easily. This study suggests that it is in that format that these rituals can be seen for what they are: cultural adaptations to high altitude stress. Though they cannot make the leap of directly affecting physiological makeup that cellular mutations can, the effect they have can still be seen as adaptive, even if in a more indirect way.

The childbirth-related rituals analyzed in this study do not directly cause adaptations by themselves, but rather act as accelerates to a previously existing process. As discussed earlier, natural selection can be slow and gradual when left to its own devices; so much so, that the time it can take for an adaptation to develop could be dangerous to a society like Tibet or Nepal, which faces extreme environmental pressures. Throughout history, however, there have been many documented cases of outside forces manipulating natural selection to take a directional course, like the previously analyzed Spartans of Greece.

While the correlation is not exact, the comparison is obvious. Like the Spartans, Tibetans use rituals in order to ensure that only the healthiest and most likely to survive go on to reproduce. Their rituals eliminate, through cultural means, those individuals who are less likely to prosper but who are still capable of surviving to pass on their weaknesses to future generations. Both societies' rituals are formed around the harsh conditions in which they exist. For the Spartans, that environment was one of hostility and rampant war, where robust, ferocious warriors were the key to the culture's survival. In the case of the Tibetans and the Nepalese, the environment is physically abusive instead of politically, however, the threat it poses is just as serious to the continuation of the culture. While Tibetans do not and never would support the deliberate destruction of a child (or any living being, for that matter), the result of their rituals remains revealingly similar to that of the Spartans'. They are accelerating the natural process of environmental selection by augmenting the environmental stresses with cultural, folklore-related childbirth rituals.

It is tempting when studying the areas of cultural and biological anthropology to function under the assumption that they exist on separate plains. Studies such as this one, however, reinforce the fact that the disciplines not only exist on the same level, but coincide in a rather intricate way. While the author initially hoped to discover independent pregnancy and birth-related rituals which contributed in specific ways to the survival of those individuals practicing them, the research instead indicated a complex

interaction between nature, biology, and culture. The religious, secular, and folklore related rituals surrounding the birthing process in the Tibetan and Nepalese cultures can be seen as cultural adaptations to high altitude stress, specifically in the ways that they augment and accelerate the natural process. By increasing the rate of genetic turnover they enable a small society with a high mortality rate, living in a hostile environment to have a fighting chance at survival. It is an excellent example of the vital role of culture to fill the void between nature and humanity.

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